United States Patent [19]

Hirata

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[45] **Date of Patent: Oct. 6, 1987**

[54] **UNDERWATER CLEANING APPARATUS**

[75] Inventor: **Kiichi Hirata**, Yokosuka, Japan

[73] Assignee: **West Tsusho Co., Ltd.**, Tokyo, Japan

[21] Appl. No.: **11,457**

[22] Filed: **Feb. 6, 1987**

Related U.S. Application Data

[63] Continuation of Ser. No. 671,187, Nov. 14, 1984, abandoned.

[30] **Foreign Application Priority Data**

Feb. 27, 1984 [JP] Japan 59-35638
Feb. 27, 1984 [JP] Japan 59-35639

[51] **Int. Cl.**[4] **B63B 59/10**
[52] **U.S. Cl.** **114/222**; 114/330; 114/333; 114/121; 114/124; 114/125
[58] **Field of Search** ..... 114/222, 124, 332, 330, 114/333, 121, 125; 15/87, 1.7, 104.1 C

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Primary Examiner—Joseph F. Peters, Jr.
Assistant Examiner—Thomas J. Brahan
Attorney, Agent, or Firm—Koda and Androlia

[57] **ABSTRACT**

Vessels and the like require cleaning either periodically or whenever a need arises to remove various living things such as seaweeds and shells or contaminants such as oil for the sake of appearance and proper performance. Divers were conventionally employed to manually remove them one by one using a scraper as one means to remove such substances. Such manual operation is, however, extremely inefficient, involving great amounts of time and labor especially for large ships. According to the present invention, the main body of a cleaning apparatus is pressed against an underwater object to be cleaned by means of impellers which are provided substantially at the center of the main body and driven to rotate, whereby cleaning brushes which are provided at the bottom of the cleaning apparatus concentrically with the impellers are rotated to remove substances adherent to the object while the cleaning apparatus is manipulated to run on the object's surface. Two pairs of an impeller and a brush are provided in parallel at the normal angle to the direction of forward and backward movement of the cleaning apparatus. The impellers and the brushes are driven by the same driving source as they are connected to the impellers by means of a universal joint.

10 Claims, 19 Drawing Figures

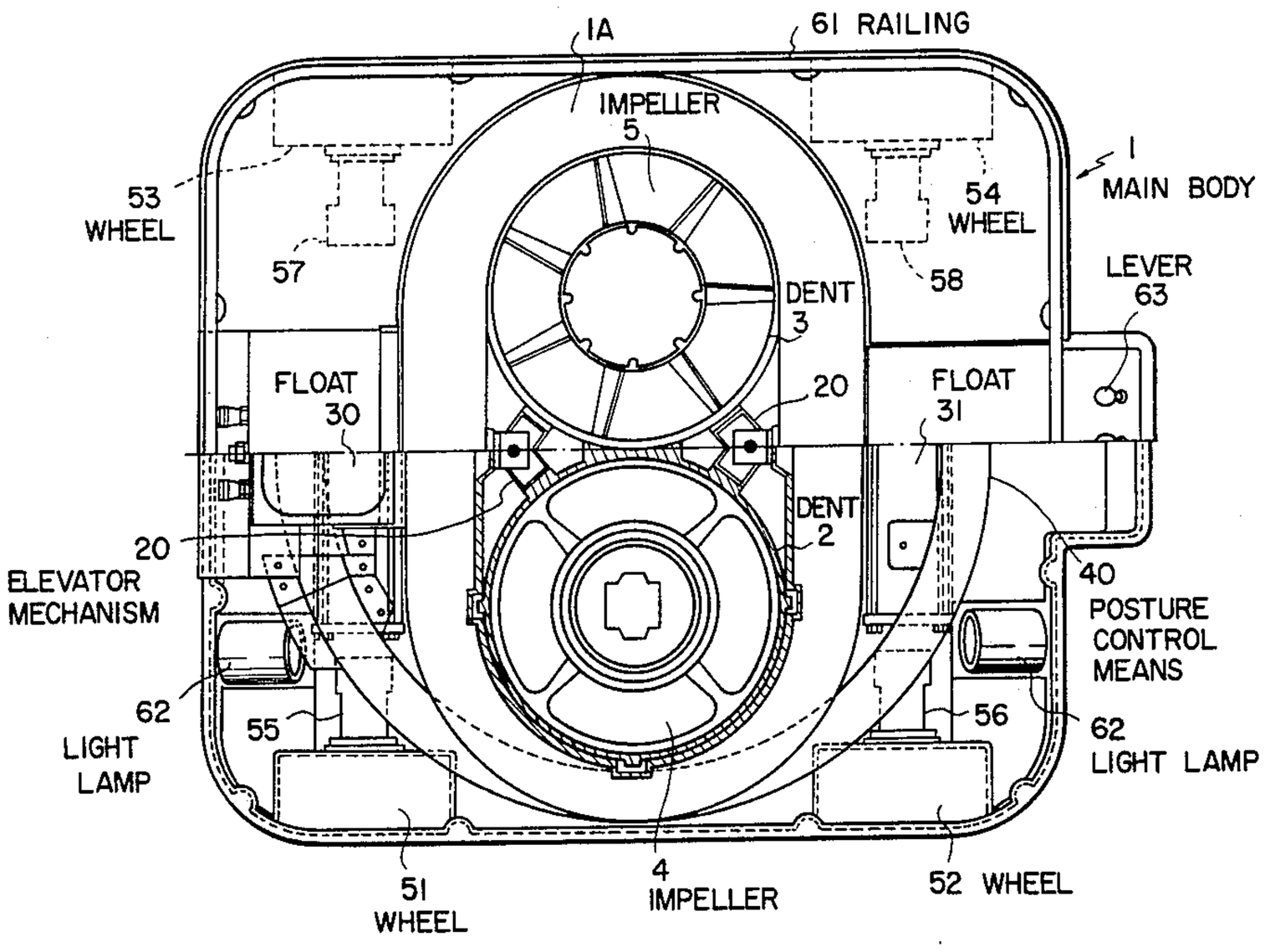


FIG. 1

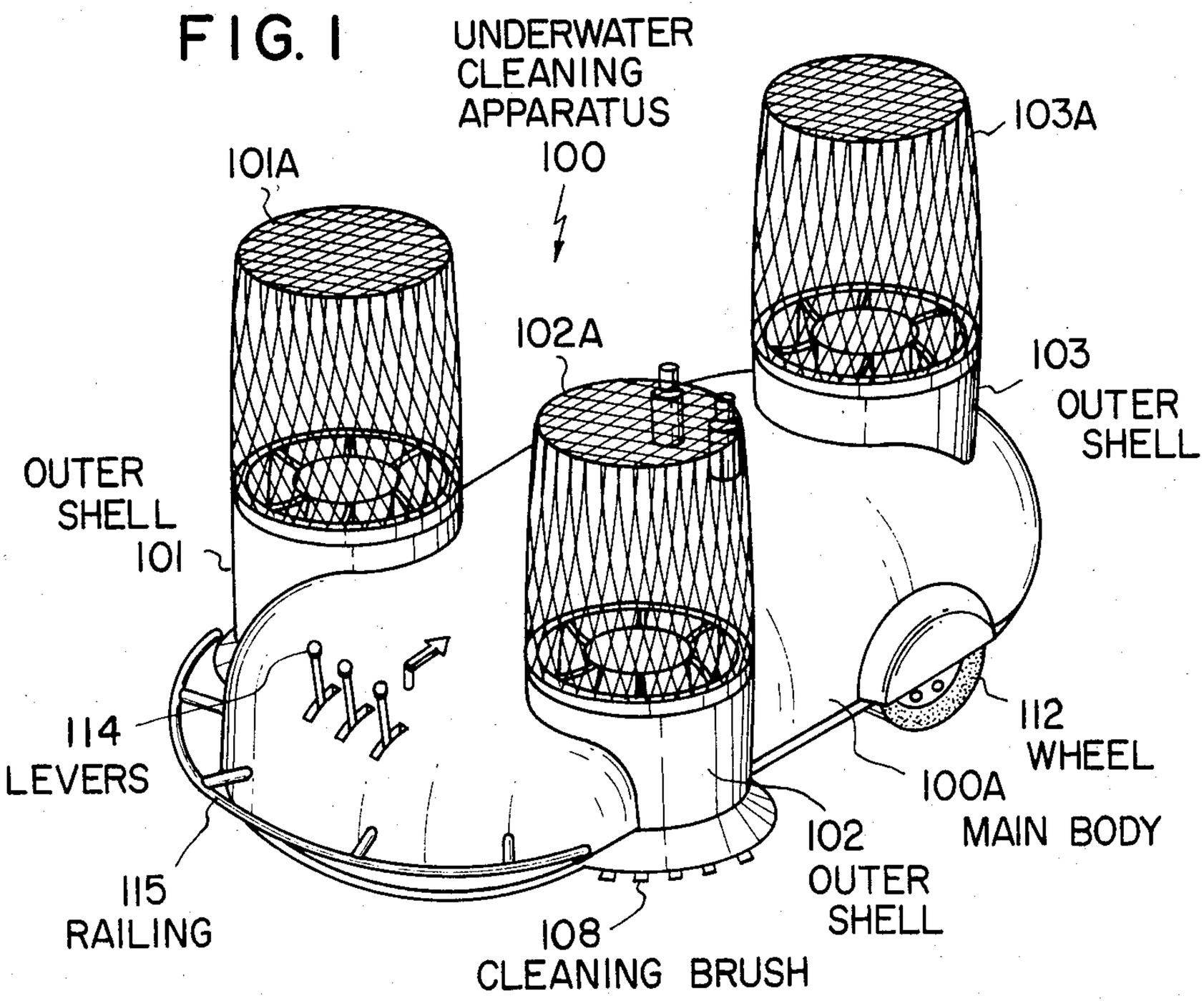

UNDERWATER CLEANING APPARATUS 100
101A
103A
102A
103 OUTER SHELL
OUTER SHELL 101
114 LEVERS
112 WHEEL
100A MAIN BODY
102 OUTER SHELL
115 RAILING
108 CLEANING BRUSH

FIG. 2

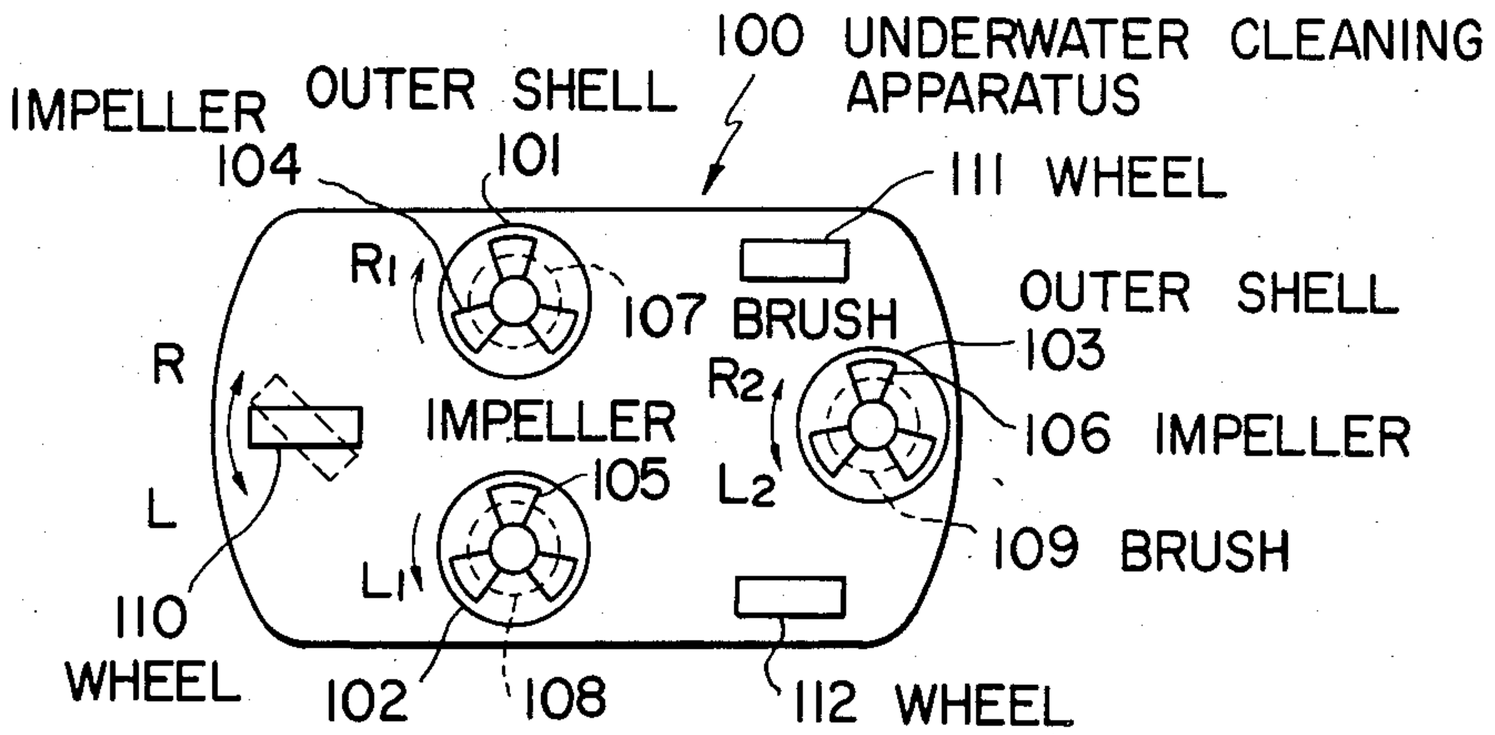
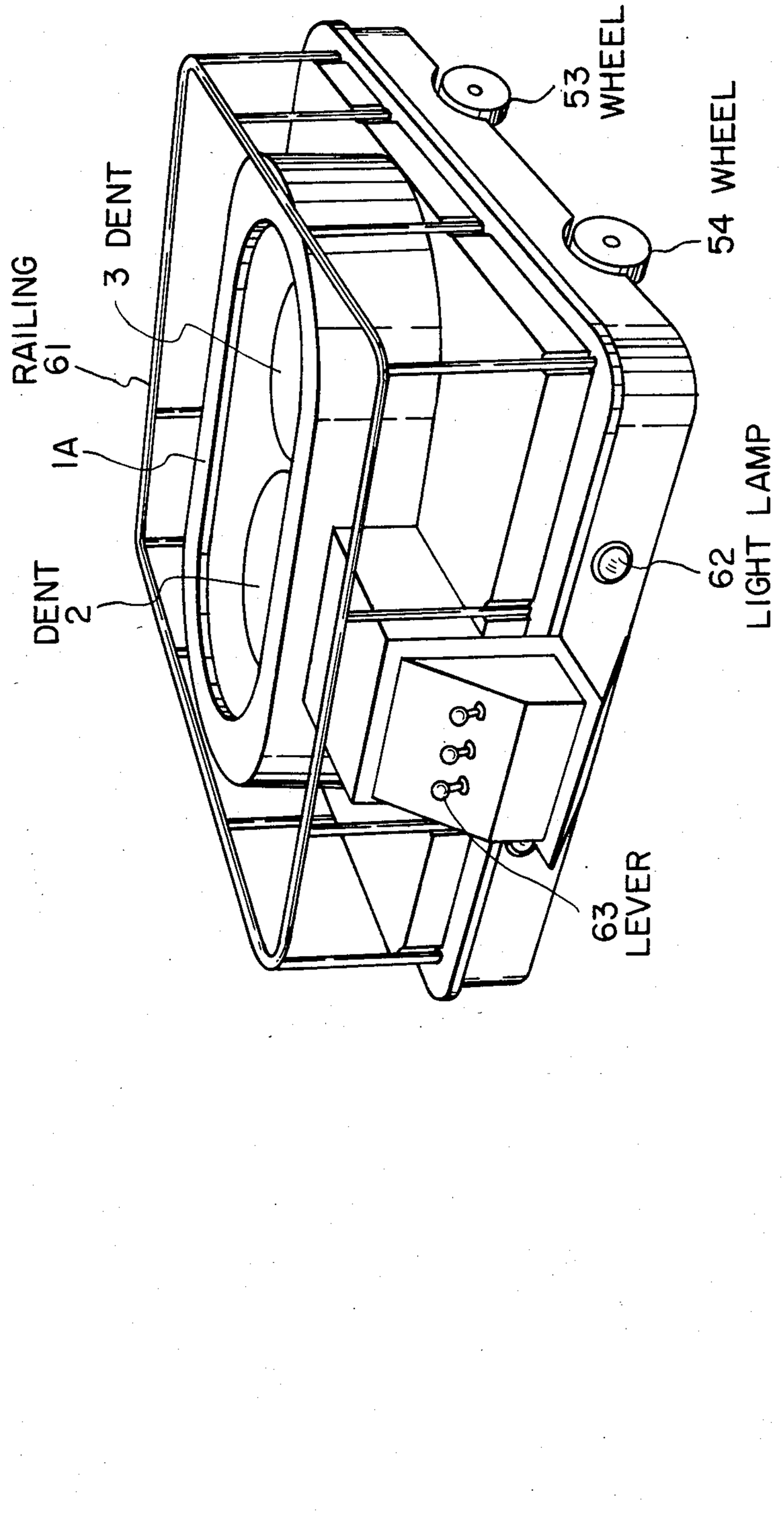

100 UNDERWATER CLEANING APPARATUS
IMPELLER 104
OUTER SHELL 101
111 WHEEL
R1
107 BRUSH
OUTER SHELL 103
R
IMPELLER
R2
106 IMPELLER
105
L
L2
109 BRUSH
L1
110 WHEEL
102
108
112 WHEEL
OUTER
BRUSH

FIG. 3


RAILING
61
3 DENT
IA
DENT
2
53
WHEEL
54 WHEEL
62
LIGHT LAMP
63
LEVER

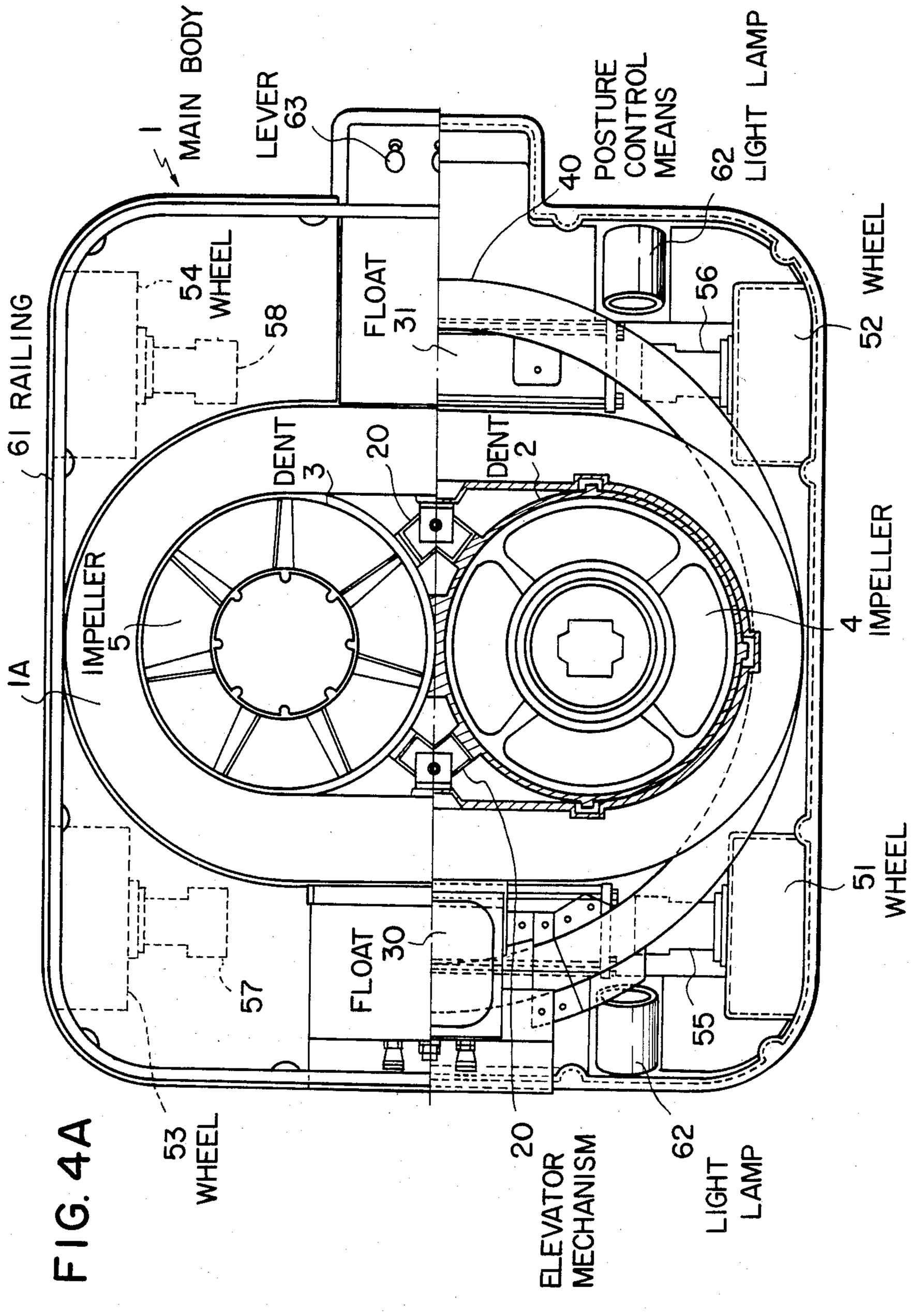

1 MAIN BODY
LEVER 63
40 POSTURE CONTROL MEANS
62 LIGHT LAMP
54 WHEEL
58
FLOAT 31
56
52 WHEEL
61 RAILING
DENT 3
20
DENT 2
IMPELLER 5
4 IMPELLER
1A
57
FLOAT 30
55
51 WHEEL
53 WHEEL
20 ELEVATOR MECHANISM
62 LIGHT LAMP

FIG. 4A

FIG. 4B

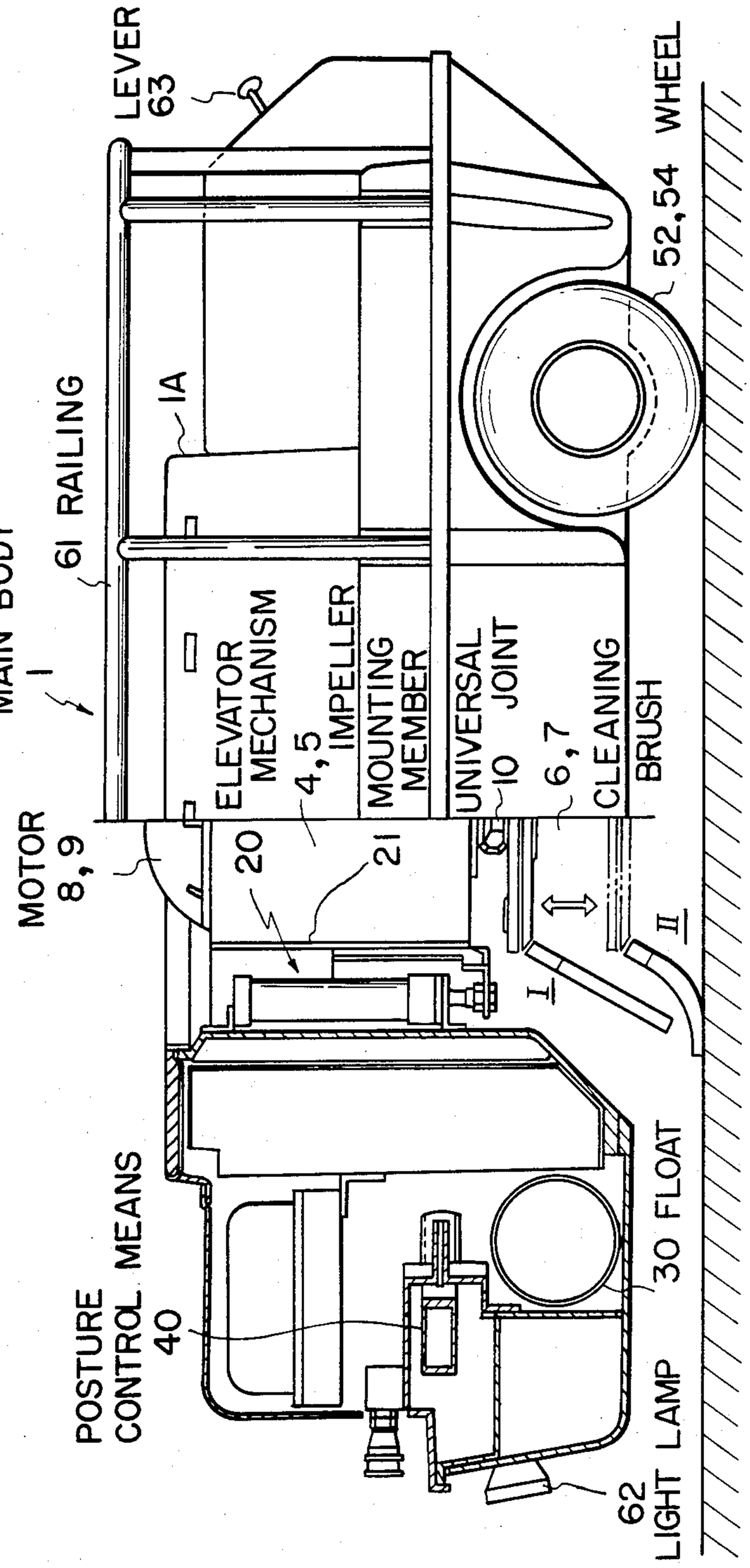

LEVER
63
MAIN BODY
1
61 RAILING
1A
ELEVATOR MECHANISM
4,5 IMPELLER
MOUNTING MEMBER
UNIVERSAL JOINT
10
6,7 CLEANING BRUSH
52,54 WHEEL
MOTOR
8,9
20
21
II
I
POSTURE CONTROL MEANS
40
30 FLOAT
62 LIGHT LAMP

FIG. 4C

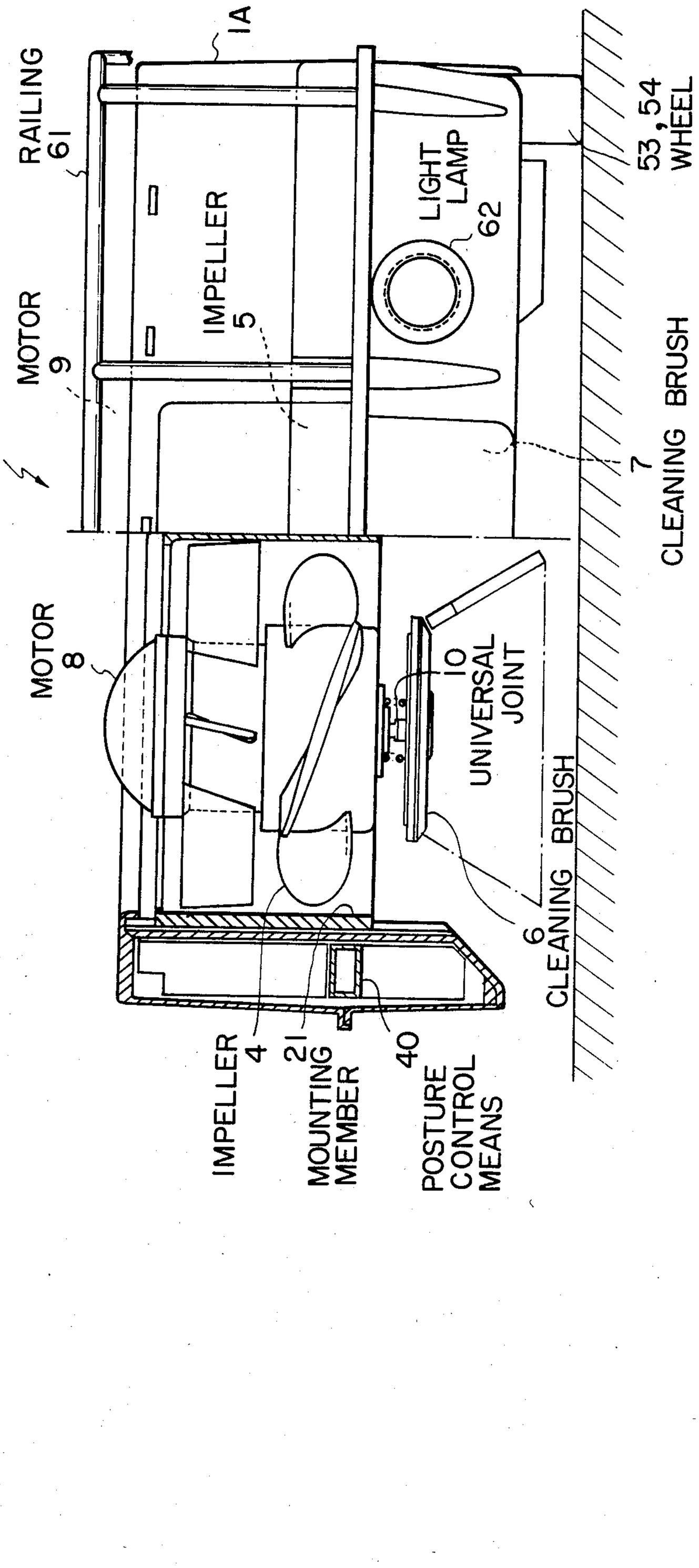

IA
RAILING
61
IMPELLER
5
LIGHT
LAMP
62
53,54
WHEEL
MAIN BODY
1
MOTOR
9
7
CLEANING BRUSH
MOTOR
8
10
UNIVERSAL
JOINT
6
CLEANING BRUSH
IMPELLER
4
21
MOUNTING
MEMBER
40
POSTURE
CONTROL
MEANS

FIG. 5

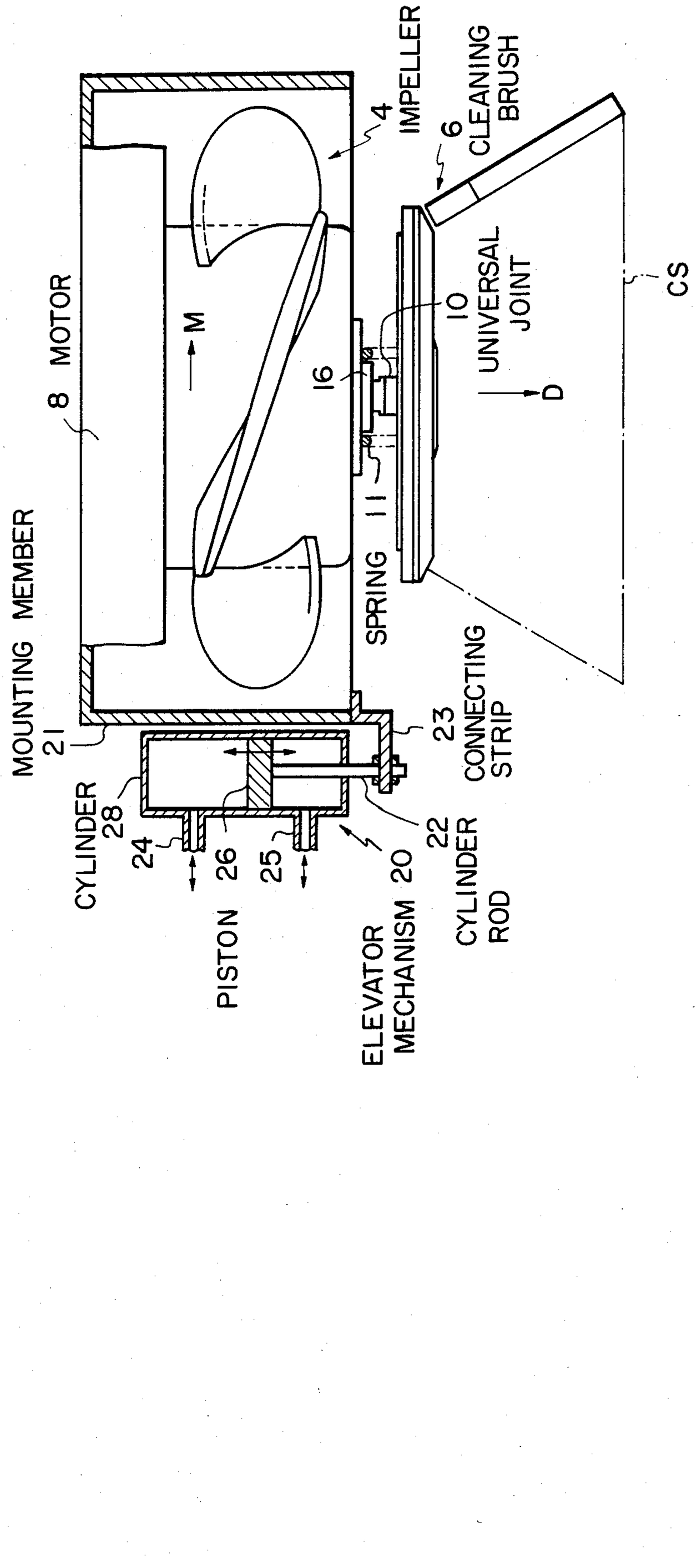

4 IMPELLER
6 CLEANING BRUSH
8 MOTOR
M
16
10 UNIVERSAL JOINT
D
CS
SPRING 11
MOUNTING MEMBER 21
CYLINDER 28
24
PISTON 26
25
ELEVATOR MECHANISM 20
22 CYLINDER ROD
23 CONNECTING STRIP

FIG. 6A

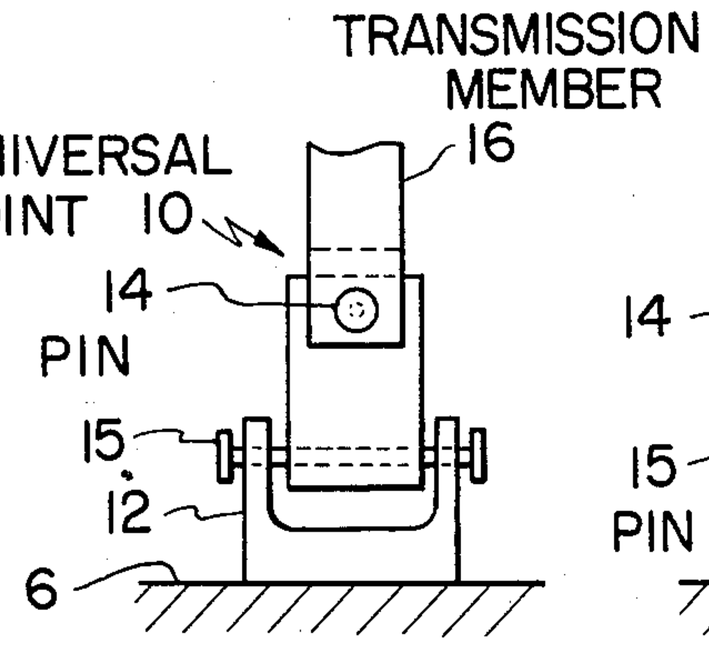


FIG. 6B

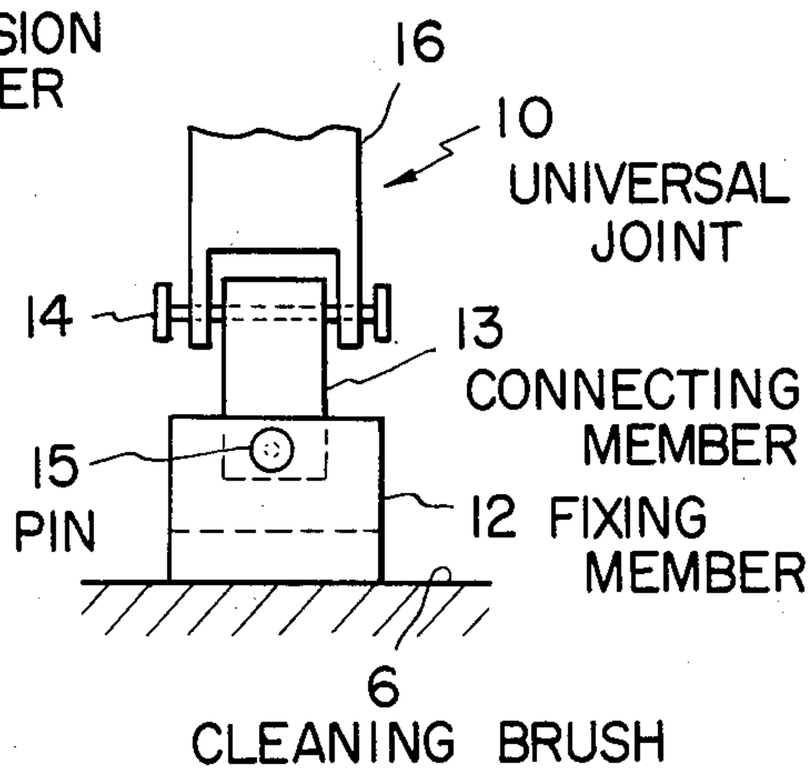


FIG. 7

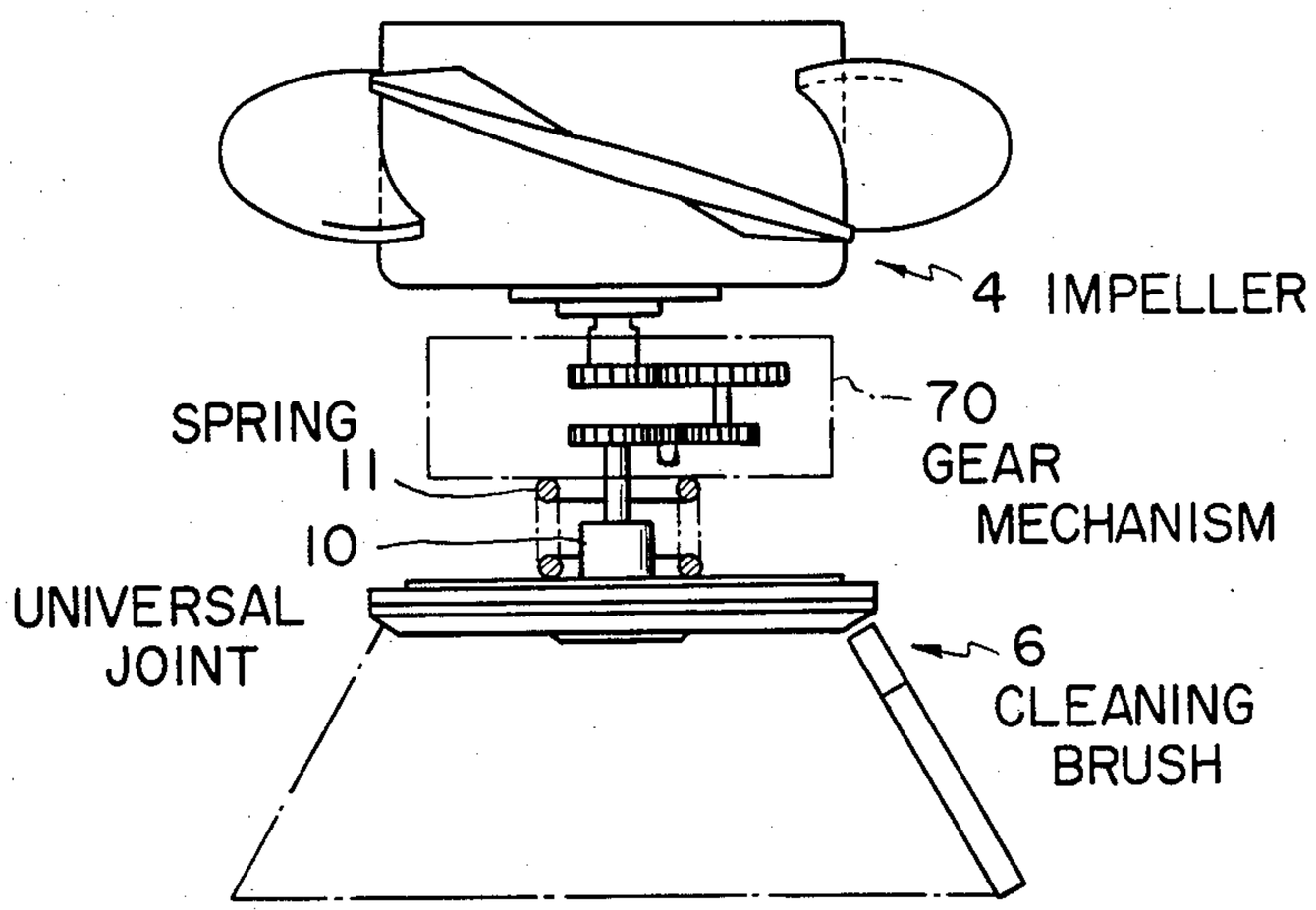


FIG. 8

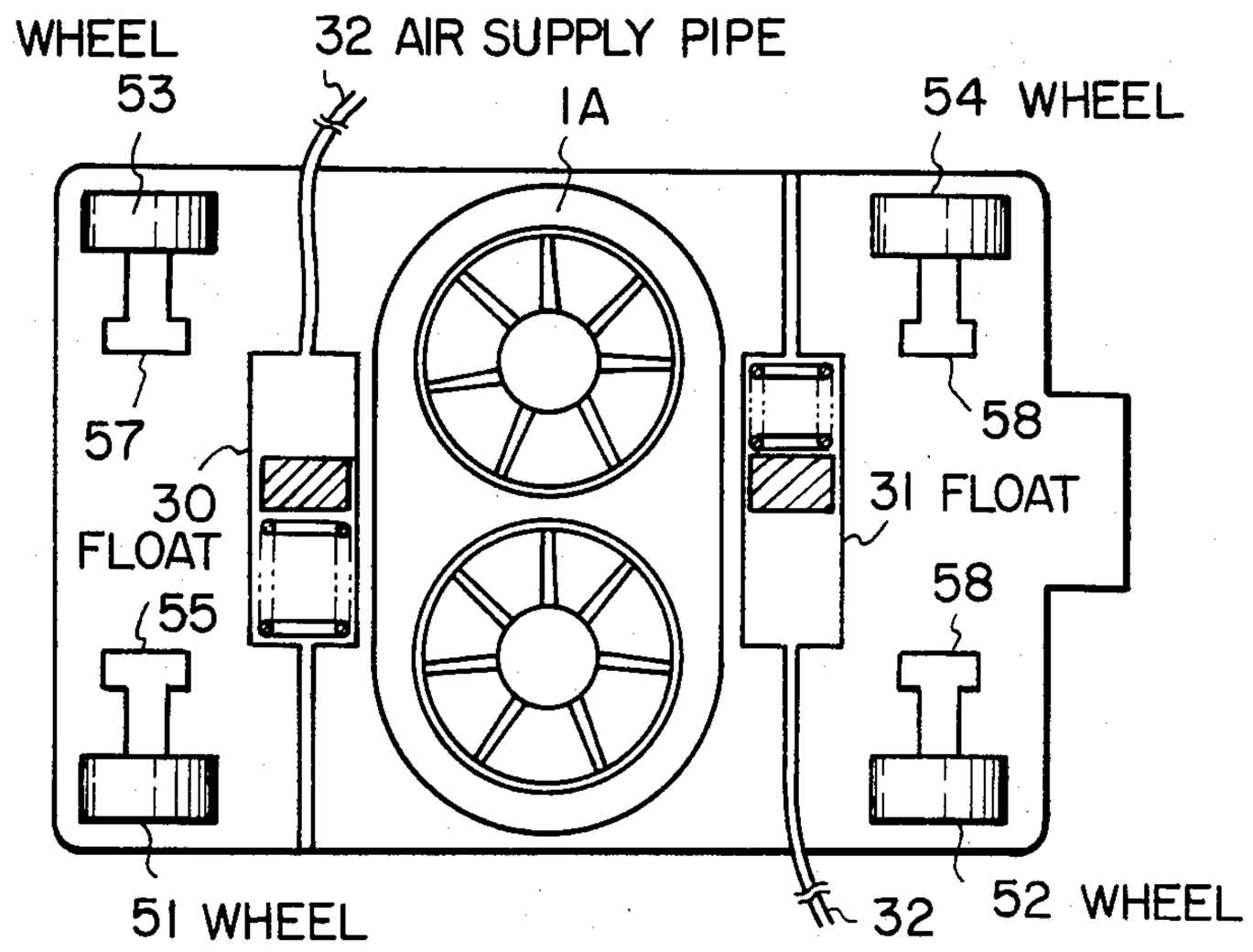

WHEEL
53
32 AIR SUPPLY PIPE
1A
54 WHEEL
57
30
FLOAT
55
58
31 FLOAT
58
51 WHEEL
32
52 WHEEL

FIG. 9

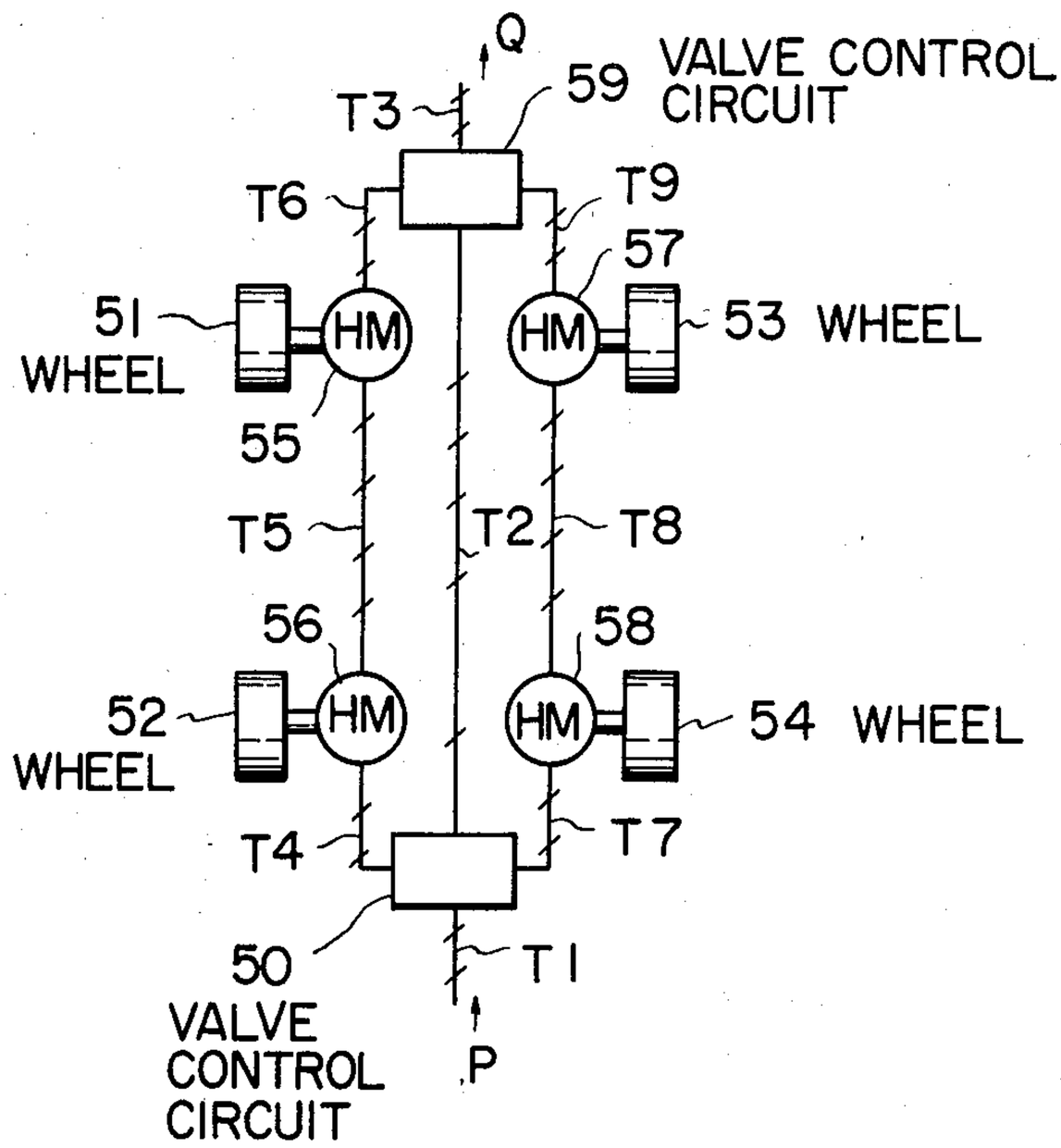

Q
T3
59
VALVE CONTROL CIRCUIT
T6
T9
57
51 WHEEL
HM
HM
53 WHEEL
55
T5
T2
T8
56
58
52 WHEEL
HM
HM
54 WHEEL
T4
T7
50 VALVE CONTROL CIRCUIT
T1
P

FIG. 10A

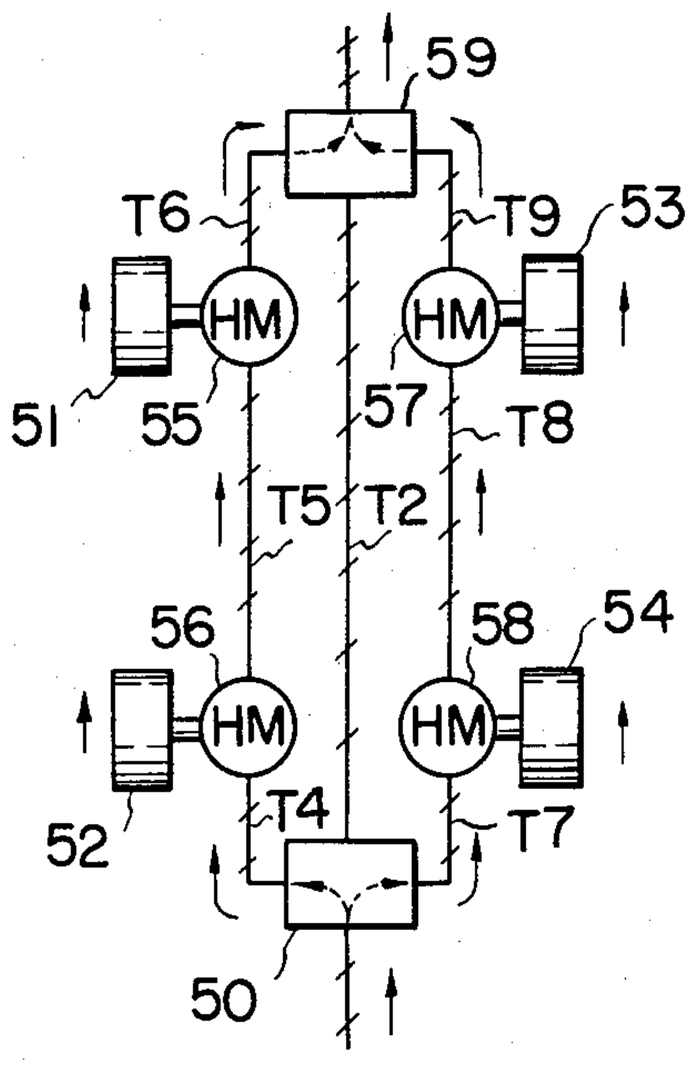


FIG. 10B

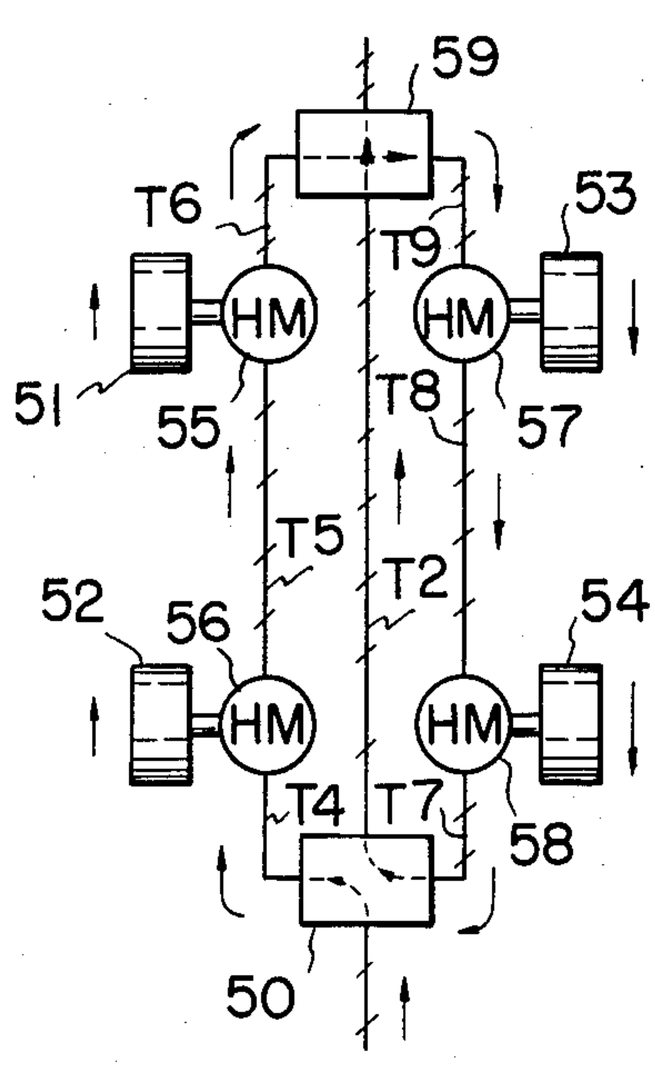


FIG. 11A

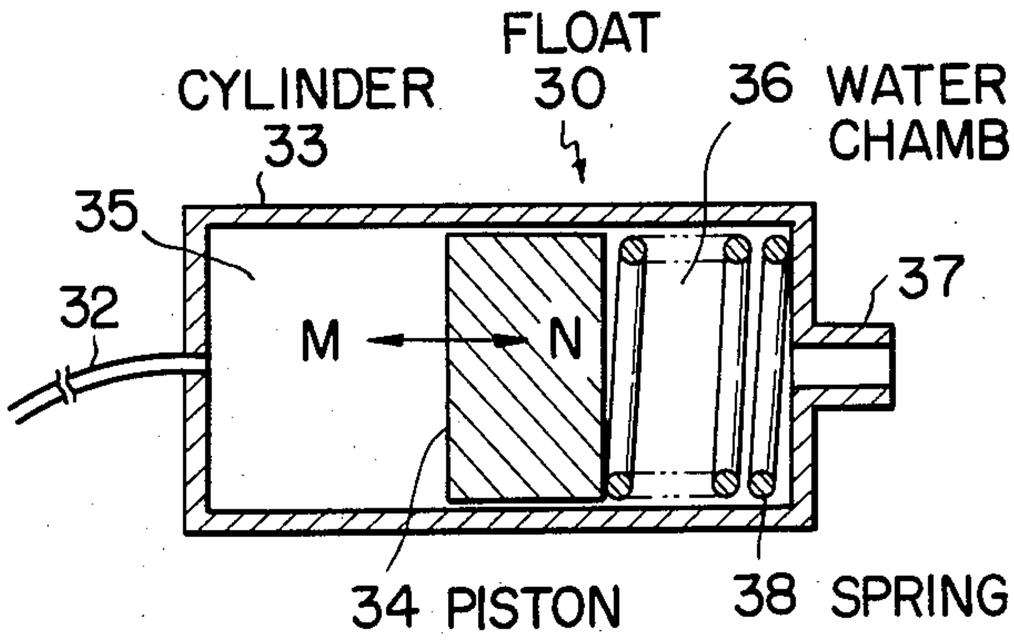


FIG. 11B

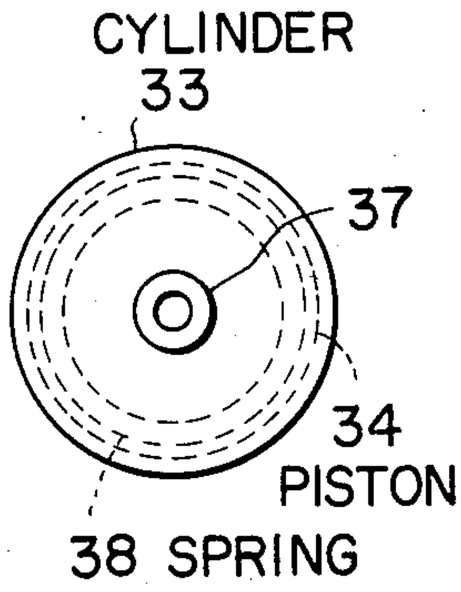


FIG. 12

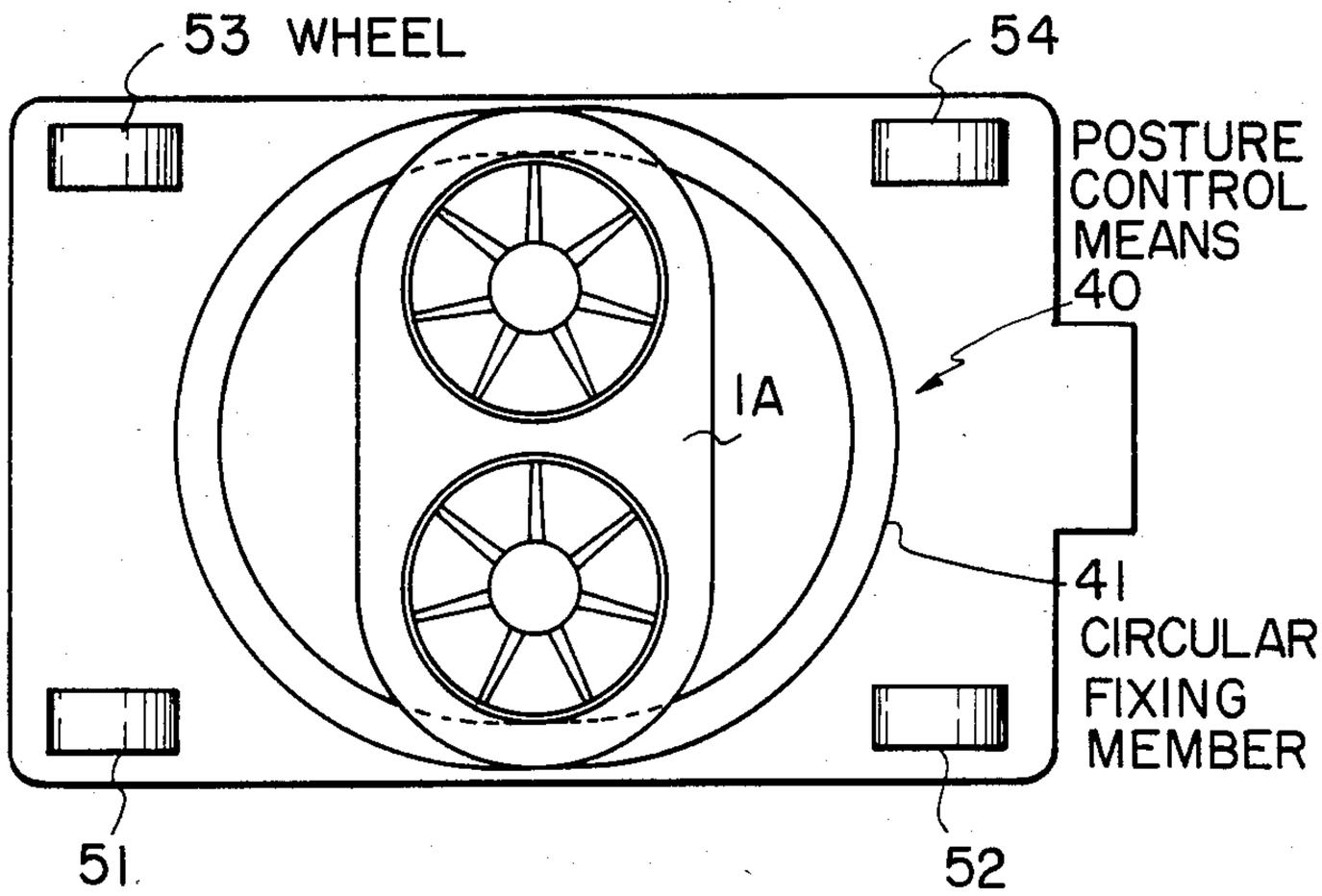


FIG. 13

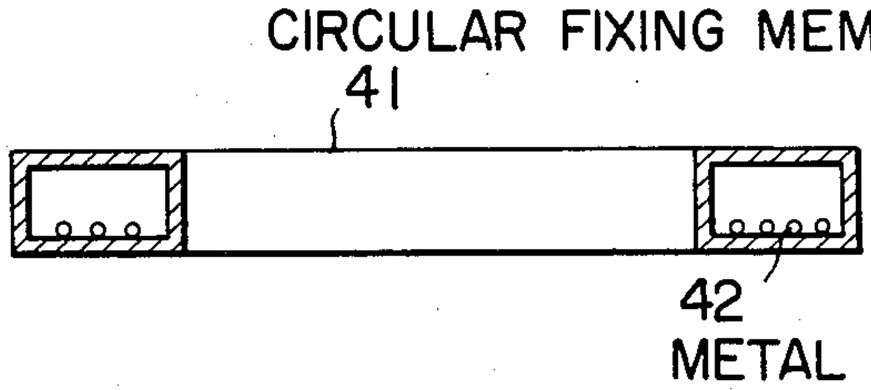
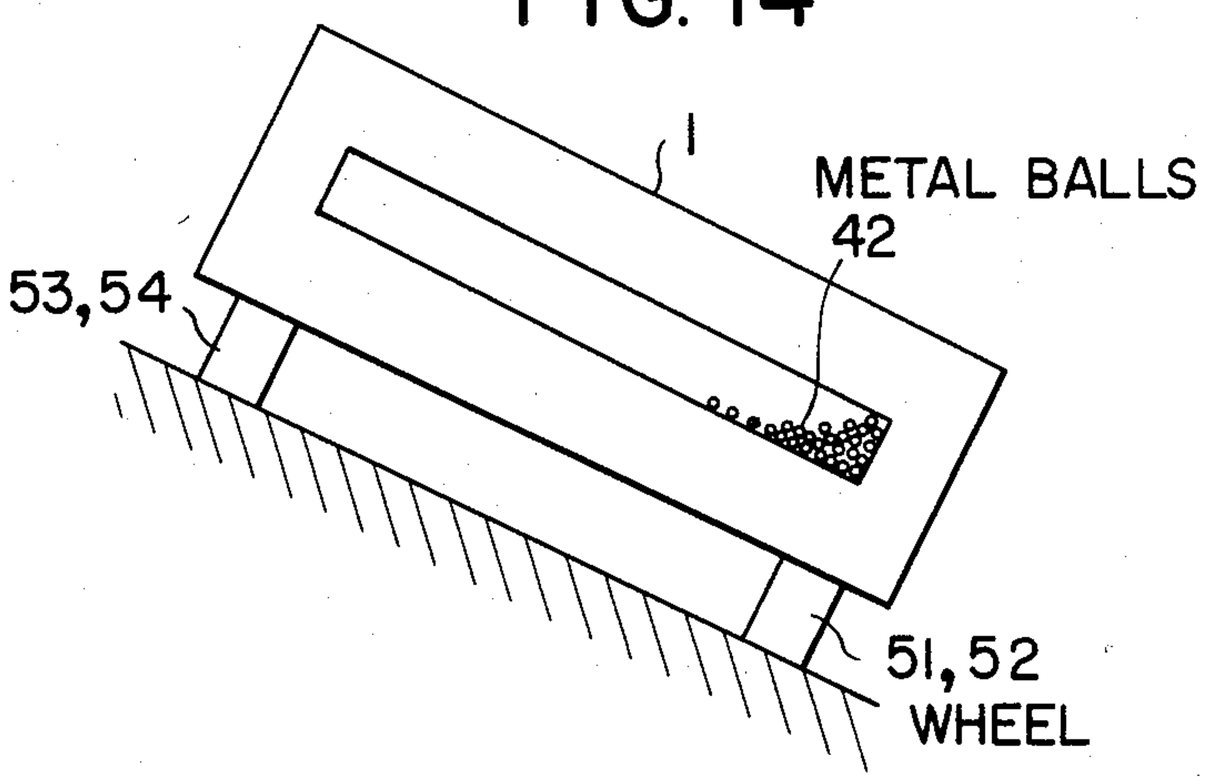


FIG. 14



UNDERWATER CLEANING APPARATUS

This is a continuation of application Ser. No. 671,187, filed Nov. 14, 1984, now abandoned.

BACKGROUND OF THE INVENTION

The present invention relates to an underwater cleaning apparatus for cleaning and removing substances adherent to vessels or structures (hereinafter referred to as cleaning object) submerged in seas or lakes, etc.

Vessels and the like require cleaning either periodically or whenever a need arises to remove various living things such as seaweeds and shells or contaminants such as oil for the sake of appearance and proper performance. Divers were conventionally employed to manually remove them one by one using a scraper as one means to remove such substances. Such manual operation is, however, extremely inefficient, involving great amounts of time and labor especially for large ships.

Various cleaning apparatuses have been proposed such as shown in schematic views of FIGS. **1** and **2** to overcome above mentioned problems (for instance, Japanese Utility Model Application No. 32107/1978). An underwater cleaning apparatus **100** shown in FIGS. **1** and **2** comprises a main body **100**A and cylindrical outer shells **101**, **102** and **103** on both sides of the rear and at the center of the front of the main body **100**A, respectively. Impellers **104** to **106** are concentrically provided inside the cylindrical outer shells **101** to **103**, so that the bottom surface of the main body **100**A is pressed against the cleaning object by the propulsion of the impellers **104** to **106** as they are driven to rotate. Three wheels **110** to **112** are provided at the bottom of the main body **100**A, by steering the wheel **110** at the back end toward the direction of either left L or right R, the underwater cleaning apparatus **100** can be manipulated in any arbitrary direction. Cleaning brushes **107** to **109** are also provided at the bottom concentrically with the impellers **104** to **106** to remove substances adherent to the object. The cleaning brushes **107** to **109** are rotated as the impellers **104** to **106** are actuated so as to remove substances adherent to the object. The impeller **104** in the outer shell **101** and the cleaning brush **107** rotates in a direction opposite to the rotational direction of the corresponding impeller **105** in the outer shell **102** and the cleaning brush **108**. The impeller **106** and the cleaning brush **109** in the outer shell **103** at the front rotate in the direction of either L2 or R2. For convenience, levers **114** are provided on the main body **100**A for controlling and manipulating the cleaning operation as well as a railing **115** for operators to hold. On top of the outer shells **101** to **103**, baskets **101**A to **103**A are attached to hold substances collected by cleaning operation.

With such as construction, the underwater cleaning device **100** is operated by manipulating the lever **114**. Since its direction of advance is controlled by steering the wheel **110** on the rear side, the direction cannot be changed on the spot without turning it around in arc. When the wheel is steered, it becomes necessary to manipulate the lever **114** to restore its original position if the apparatus is to move straight ahead. Further, since there are an odd number (3 in this case) of impellers **104** to **106** with the cleaning brushes **107** to **109** connected thereto, the overall balance of the apparatus is difficult to be maintained despite of the efforts to maintain the balance by rotating the outer shells **101** and **102** at the

back in opposite directions. This is because impellers **106** and the cleaning brush **109** in the outer shell **103** at the front must always rotate in the direction of either L2 or R2. With the conventional apparatus, the cleaning brushes **107** to **109** are fixed to the impellers **104** to **106**, respectively. Although this poses no problem when cleaning a flat surface, cleaning of an irregular surface becomes difficult because the brushes per se are incapable of making vertical movement and may clash with the surface of the object depending on the position of the underwater cleaning apparatus **100** or cause themselves or the object surface to be damaged. There is provided no means to adjust the buoyancy or the posture of the main body **100**A in the conventional cleaning apparatus **100**. Thus, the buoyancy of the cleaning apparatus **100** may greatly vary depending on whether the water is fresh or brine, preventing smooth operations. The apparatus may become unbalanced depending on the direction or the posture of operation. It also poses problems in respect of energy consumption as it requires great force in manipulation. As the main body **100**A is substantially circular in plan view, it was difficult to remove adherent substances from the corners of the object.

SUMMARY OF THE INVENTION

An object of this invention is to provide an underwater cleaning apparatus which can assure smooth and thorough cleaning of an underwater object.

Another object of this invention is to provide an underwater cleaning apparatus which is possible to change the direction thereof on the spot and to move straight ahead without manipulation of the lever.

Still another object of this invention is to provide an underwater cleaning apparatus which is possible to easily maintain the balanced posture and to control the buoyancy according to the surroundings.

According to this invention in one aspect thereof, for achieving objects described above, there is provided an underwater cleaning apparatus comprising a main body, impellers provided substantially at the center of said main body to press the same against the surface of a cleaning object by its rotation, and cleaning brushes provided on said main body at its bottom which are pressed against the object and are concentrical with said impellers to remove substances adherent to the object by rotating, said cleaning apparatus being characterized in that said main body is made movable on the object surface by the rotation and driving force of the impellers, a pair each of the impellers and the cleaning brushes are provided in parallel and at the normal angle with respect to the direction in which the apparatus moves forward and backward and the impellers and the brushes are driven by one driving source by connecting them by means of a universal joint.

According to this invention in another aspect thereof, there is provided an underwater cleaning apparatus with a buoyancy control means comprising a main body, impellers provided substantially at the center of said main body to press the same against the surface of a cleaning body by its rotation, and cleaning brushes provided on said main body at its bottom which are pressed against the cleaning object and are concentrical with said impellers to remove substances adherent to the object by rotating, said cleaning apparatus being characterized in that said main body is made movable on the object surface by the rotation and driving force of the impellers, cylindrical floats having a variable

capacity are provided either in front of and at the back of or on both sides of the impellers so as to control the buoyancy of said main body of the cleaning apparatus under water.

Further, according to this invention in still another aspect thereof, there is provided an underwater cleaning apparatus with posture control means comprising a main body, impellers provided substantially at the center of said main body to press the same against the surface of a cleaning body by its rotation, and cleaning brushes provided on said main body at its bottom which are pressed against the cleaning object and are concentrical with said impellers to remove substances adherent to the object rotating, said cleaning apparatus being characterized in that said main body is made movable on the object surface by the rotation and the driving force of the impellers; and a circular fixing member which surrounds said impellers and which seals movable substance in its hollow wall so that the movable substance may move in the hollow wall in correspondence with the horizontal movement of the cleaning apparatus, is provided.

The nature, principle and utility of the invention will become more apparent from the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. **1** is a prespective view showing one embodiment of a conventional underwater cleaning apparatus;

FIG. **2** is a view to explain the functions thereof;

FIG. **3** is a perspective view showing one embodiment according to the present invention;

FIG. **4A** is a plan view partly in section showing the structure of the embodiment;

FIG. **4B** is a partial sectional view showing the structure of the embodiment from the side;

FIG. **4C** is a partial view showing the structure of the embodiment;

FIG. **5** is a view partly in section showing the structure of the impellers and brushes in detail;

FIG. **6A** is a front view showing the structure of a universal joint;

FIG. **6B** is a side view thereof;

FIG. **7** is a view partly in section showing another embodiment of connecting means between the impellers and the brushes;

FIG. **8** is a schematic diagram showing the construction of the present invention regarding the buoyancy;

FIG. **9** and FIGS. **10A** and **10B** are views to explain the control means for the wheels, respectively;

FIG. **11A** is a sectional view showing the structure of a float used in the present invention;

FIG. **11B** is a side view thereof;

FIG. **12** is a functional view showing one embodiment of the posture control means according to the present invention;

FIG. **13** is a sectional view showing the structure of the posture control means; and

FIG. **14** is a view showing a state of the posture control means.

DETAILED DESCRIPTION OF THE INVENTION

The present invention will now be described in more detail.

FIG. **3** and FIGS. **4A** through **4C** show the appearance and the structure of one embodiment according to the present invention. The underwater cleaning apparatus according to the present invention comprises a rectangular main body **1** which is substantially a square in plan view with an elliptic cavity **1A** at the center of the main body **1**, cylindrical dents **2** and **3** bored inside the cavity **1A**, impellers **4** and **5** inside the dents **2** and **3** respectively, and cleaning brushes **6** and **7** respectively connected to the bottom of the impellers **4** and **5** by means of a universal joint **10**. Motors **8** and **9** are connected to the impellers **4** and **5** at the top thereof to drive and rotate the same in opposite directions to each other. Inside the dents **2** and **3** is also provided an elevator mechanism **20** for moving a mounting member **21** vertically by means of an oil pressure cylinder, the mounting member **21** fixedly mounting the impellers **4** and **5**. The elevator mechanism **20** is controlled by lever **63** (or by remote control) provided at the rear of the cleaning apparatus **1**. The mounting member **21** is also mounted fixedly with the oil pressure motor **8** (or **9**), at the bottom of which is connected the impeller **4** (or **5**) as well as the brush **6** (or **7**) via the universal joint **10**. Thus, as the mounting member **21** is vertically moved by means of the elevator mechanism **20**, the cleaning brushes **6** and **7** move freely within the range between the position I (upper limit) and the position II (lower limit) as indicated in FIG. **4B**.

Floats **30** and **31** are provided in parallel on the main body **1** in front of and at the back of the dents **2** and **3**, respectively, for controlling the buoyancy of the apparatus to maintain its balance. Above the floats **30** and **31** is provided a posture control means **40** which surrounds dents **2** and **3** in the form of a true circle with a hollow inside so that the posture control means **40** controls the posture of the main body **1** with less energy. Four wheels **51** to **54** are provided at the four corners of the bottom of the main body **1** for mobility. The wheels **51** and **52** on one side and the wheels **53** and **54** on the other side of the axis along the direction of the forward and backward movement of the apparatus are driven independently and serially by oil pressure motors **55** through **58**. A railing **61** is provided along the outer periphery of the main body **1** for the operator to hold or for other convenience. Light lamps **62** are provided at the front and back of the bottom to facilitate the operation in dim places such as at the sea bottom or to prevent any hazards. A net basket may be attached to the top of the cavity **1A** to collect the removed substances.

FIG. **5** shows the construction of the impellers **4** and **5** and the cleaning brushes **6** and **7** in detail together with the universal joint **10** which connects the above two members. When, for example, the impeller **4** is rotated in the direction M in the figure by means of the oil pressure motor **8**, propulsion in the direction D can be obtained. The rotation of the impeller **4** is transmitted to the cleaning brush **6** via the universal joint **10**. Because of the connection by the universal joint **10**, the cleaning surface CS of the cleaning brush **6** can be slanted at any arbitrary angle to accommodate with the curvature of the object. A spring **11** is inserted between the impeller **4** and the cleaning brush **6** in a manner to surround the universal joint **10**, so that the cleaning surface CS of the cleaning brush **6** can be maintained horizontal under normal condition. The oil pressure motor **8** is fixed to the mounting member **21** which is connected by means of a connecting strip **23** to the cylinder rod **22** of the elevator mechanism **20**, the cylin-

der rod **22** being fixed to the mechanism at its bottom at the main body **1**. The elevator mechanism **20** comprises a piston **26** and a cylinder **28** which houses the piston **26**. In one section of the cylinder **28** partitioned by the piston **26**, pressurized oil is flowed in or out via an injection pipe **25**; in the other section, an injection pipe **25** is provided for the same purpose. By changing the amount of oil pressure in the two sections divided by the piston **26** via the injection pipes **24** and **25**, the piston **26** will move vertically to thereby move the mounting member **21** via the cylinder rod **22** and the connecting strip **23** which are connected to the piston **26**. FIGS. **6A** and **6B** show an embodiment of the structure of the universal joint **10**. A fixing member **12** of the cleaning brush **6** has a dent which is in an orthogonal relation to the dent made in a transmission member **16** of the impeller **4**, and between the members **12** and **16** is provided a connecting member **13**. The connecting member **13** and the fixing member **12** are journalled by a pin **15**, and the connecting member **13** and the transmission member **16** by a pin **14**. In this manner, the rotational force from the transmission member **16** is directly transmitted to the cleaning brush **6**, which, at the same time, is made capable of freely directing its cleaning surface CS at an arbitrary angle and direction. It should be noted that the structure of the universal joint **10** is not limited to the one shown in FIGS. **6A** and **6B** but any structure may be employed so long as the rotational force of the impeller **4** is directly transmitted to the object and the cleaning surface CS of the cleaning brush **6** which is connected to the impeller **4** is directed in correspondence with the contour of the object.

FIG. **7** shows another embodiment of the driving mechanism for the cleaning brushes **6** and **7**. A gear mechanism **70** is interposed between the universal joint **10** and the impeller **4**, so that the impeller **4** and the cleaning brush **6** connected therewith may rotate in the opposite directions. As the impeller **4** and the cleaning brush **6** rotate in the opposite directions to each other, the water flow in the dent **2** becomes even and smooth and at the same time removal and disposal of substances becomes more effective.

FIG. **8** is a schematic diagram of the structure of the apparatus according to the present invention to show the positional relation of the floats **30, 31** and the wheels **51** through **54**. The floats **30** and **31** are supplied with pressurized air via an air supply pipe **32** which is connected to a control means provided on a ship and the like. The floats **30** and **31** are positioned point-symmetrically with respect to the cavity **1A** in order to maintain the overall balance of the device. The structure and the operation of the floats **30** and **31** will be described later. The wheels **51** to **54** are provided at the four corners of the bottom of the main body **1**. FIG. **9** shows the driving mechanism for the wheels **51** to **54**. Oil pressure is introduced from an oil pressure conduit **T1** in the direction P and discharged from an oil pressure conduit **T3** in the direction Q via valve control circuits **50** and **59**. The valve control circuits **50** and **59** are connected directly with one another by an oil pressure pipe **T2** while oil pressure motors **55** to **57** are connected by oil pressure conduits **T4** to **T9**, respectively.

With the structure as described above, the wheels **51** and **52** and the wheels **53** and **54** are respectively regarded as one unit each arranged in parallel in the direction of the forward and backward movement of the apparatus and they may be controlled to move in the same direction at the same speed. Each wheel can also be controlled independently of the other wheels. In other words, in the case where the wheels **51** and **52** are controlled to advance and the wheels **53** and **54** are controlled in the same direction as above, the valve control circuits **50** and **59** are switched, as indicated in FIG. **10A**, so as to introduce oil pressure from the valve control circuit **50** into the oil pressure motors **56** and **58** by branching out the oil pressure into the oil pressure conduits **T4** and **T7**. The oil pressure is further introduced to the oil pressure motors **55** and **57** via the conduits **T5** and **T8**. The oil pressure from the motors **55** and **57** is then introduced to the valve control circuit **59** via the oil pressure conduits **T7** and **T9** to be discharged from the oil pressure conduit **T3**. In this case, the amount of oil pressure to be introduced to the oil pressure conduits **T4** and **T7** can be individually controlled by controlling the valve control circuit **50**. Thus, the speed of the motors **55** and **56** and the motors **57** and **58** may be differentiated, thereby controlling the direction of the cleaning apparatus. When the cleaning apparatus is to be moved straight ahead, it goes without saying that the motors are run at the same speed. In the case where the cleaning apparatus is to be turned around at one spot, the wheels **51** and **52** on one side of the cleaning apparatus are driven forward while the wheels **53** and **54** on the other side are driven backward (refer to FIG. **10B**). This is achieved by so controlling the valve control circuits **50** and **59**. Flow of the oil pressure into the oil pressure conduits **T1** to **T9** is controlled as shown in the figure. The cleaning apparatus can thus be turned around at one spot without taking a great span of space. Likewise, the wheels **51** and **52** may be driven backwards while the other two wheels forward. The forward and backward movements can be controlled by the valve control of the valve control circuit **59**.

FIGS. **11A** and **11B** show the structure of the float **30** (or **31**), which comprises a cylinder **33**, and a piston **34** inserted in the cylinder **33** and attached therewith via an O-ring. The inside of the cylinder **33** is partitioned into an air chamber **35** and a water chamber **36** by the piston **34**. A liquid inlet/outlet pipe **37** is provided in the wall of the water chamber **36** so that liquid such as seawater may freely flow in and out. A spring **38** is mounted in the water chamber **36** of the cylinder **33** and energizes the piston **34** at all times in the direction M. The capacity of the air chamber **35** may be varied by controlling the amount of air supplied from the air supply pipe **32** to thereby control the buoyancy of the float **30**. In other words, when the air is introduced into the air chamber **35** under pressure, the piston **34** is pushed in the direction N so that the liquid in the water chamber **36** is discharged from the liquid outlet pipe **37** to thereby increase the buoyancy of the float **30**. On the other hand, when the air pressure from the pipe **32** is reduced, liquid will spontaneously flow into the water chamber **36** because of the pressing action of the spring **38** and of the pressure of the deep seawater. The piston **34** is pushed in the direction M and, as a consequence, the capacity of the air chamber **35** decreases to thereby reduce the buoyance of the float **30**. Thus, the capacity of the air chamber **35** is made variable by changing the amount of air supplied from the pipe **32** and the buoyancy of the float **30** can be controlled at will. Since the floats of such a construction are positioned symmetrically on both sides of the cavity **1A**, the buoyancy of the cleaning apparatus can be accurately controlled while maintaining the balance. It is noted that the number of

floats is not restricted to two but may be increased an may also be positioned on both sides of the apparatus.

FIG. **12** shows the structure of the posture control means **40** according to the present invention. A circular fixing member **41** with a hollow inside is fixed to the periphery of the cavity **1A**. The fixing member **41** in section is rectangular (refer to FIG. **13**). Inside the member **41**, there are provided a number of metal balls **42** such as used in the pin ball game. These metal balls **42** roll freely inside the hollow cavity of the circular fixing member **41**. When the cleaning apparatus is at a level position, the metal balls **42** are substantially evenly distributed. When the cleaning apparatus is positioned inclined such as on a slope, the metal balls **42** will roll over to one side, as shown in FIG. **14**, thus shifting the center of gravity of the cleaning apparatus. This saves energy and eliminates use of a great driving force to control the movement of the cleaning apparatus. The posture of the cleaning apparatus can thus be easily shifted at a speed with less power. The posture control of this type which helps reduction of the force required to drive the main body bears a great significance in a cleaning apparatus such as the present invention as it is manipulated and operated under water where there is almost no gravity. Although the metal balls **42** are employed in the embodiment, mercury may be sealed instead in the fixing member **41** if it can be tightly sealed therein. In the case where mercury is used, oil which has a small specific gravity may be used to cover the mercury layer so as to prevent leakage of mercury vapor.

The cleaning apparatus having the above construction is pressed against the cleaning object by propulsion generated by the rotation of the impellers **4** and **5** which are operated by the lever **63**, and moves freely on the object as the wheels **51** to **54** are driven. At this stage, the cleaning brushes **6** and **7** are raised at the position I. When the cleaning apparatus reaches a position where substances to be cleaned are found, the elevator mechanism **20** is operated to lower the cleaning brushes **6** and **7** to be rotated for cleaning operation at the position II. The cleaning brushes **6** and **7** are made of metal strips or needles and are capable of removing shells and seaweeds adherent to the object by the pressing and rotating forces thereof. The buoyancy and the posture of the cleaning apparatus are also controlled at this stage by the floats **30** and **31** and the posture control means **40**, respectively.

As has been described in the foregoing, the cleaning brushes **6** and **7** according to the present invention are vertically movable by means of the elevator mechanism **20**. When the cleaning brushes are not in use, they are raised at the position I as shown in FIG. **4B** so that they do not come in contact with the object surface while the wheels **51** to **54** are driven. When the cleaning apparatus reaches a position where cleaning is desired, the brushes **6** and **7** are lowered by means of the elevator mechanism **20** to the position II as shown in FIG. **4B**, at which position they are rotated for cleaning operation. This assures thorough and accurate cleaning. As the cleaning brushes **6** and **7** are vertically movable, there is no risk of damaging either the object surface or the brushes themselves by clashing with the projected portions even when the cleaning apparatus moves on an uneven surface.

As has been described in the foregoing, the underwater cleaning apparatus according to the present invention is provided with an even number of impellers and brushes (in this case, 2) so that the apparatus does not lose its balance by the rotation of the impellers and the brushes. Provision of floats either in front of and at the rear of or on both sides of the axis along the direction of forward and backward movement enables accurate control of the buoyancy even if it may vary depending on the salt content of the seawater. As the posture control mechanism of the present invention comprises a hollow wall and moving member which may freely roll or flow inside the hollow wall, the underwater cleaning apparatus can be controlled with respect to its positions with less power because when the device is to be moved toward a slope, the moving member inside the hollow wall immediately follows suit. Moreover, there are provided four wheels in the apparatus that can be controlled independently in pairs with respect to the forward or backward movement. This eliminates steering of wheels and the apparatus can be turned around at one spot with great ease. Because the cleaning brushes are vertically movable, damages which may otherwise occur during driving of the apparatus can be prevented and accurate removal of substances is assured. As the main body of the apparatus is rectangular in plan view, it allows the tip of the brushes to reach even the small corners for thorough cleaning.

What is claimed is:

1. An underwater cleaning apparatus comprising a main body, impellers provided substantially at the center of said main body to press the same against the surface of a cleaning object by its rotation, and cleaning brushes provided on said main body at its bottom which are pressed against the object and are concentrical with said impellers to remove substances adherent to the object by rotating, said cleaning apparatus being characterized in that said main body is made movable toward the object surface by the rotation and driving force of the impellers, a pair of each of the impellers and the cleaning brushes are provided in parallel and at the normal angle with respect to the direction in which the apparatus moves forward and backward, the impellers and the cleaning brushes are driven by one driving source by connecting them by means of a universal joint, said pair of impellers are rotated in opposite directions of their associated cleaning brushes, there is provided cylindrical floats having a variable capacity at least in front of and at the back of the impellers so as to control the buoyancy of said main body of the cleaning apparatus underwater, there is provided a circular fixing member which surrounds said impellers and which seals movable substances in its hollow wall so that the movable substances may move in the hollow wall in correspondence with the horizontal movement of the cleaning apparatus, and further there is provided a wheel at each of the four corners of said main body at its bottom and the wheels on one side of the axis in the direction of the forward and backward movement are driven independently of the wheels on the other side of the axis to rotate in opposite directions at variable speeds.

2. The underwater cleaning apparatus as claimed in claim **1**, wherein a gear mechanism is interposed between each of said impellers and its associated universal joint so that each of said impellers and its associated cleaning brush rotate in opposite directions.

3. The underwater cleaning apparatus as claimed in claim **2** wherein said cleaning brushes are made vertically movable.

4. The underwater cleaning apparatus with buoyancy control means as claimed in claim 1, wherein said floats respectively comprise a cylinder and a piston inserted into said cylinder so that pressurized air can be introduced into a first section of the cylindrical partitioned by the piston while surrounding water is introduced into a second section of the cylinder.

5. The underwater cleaning apparatus with buoyancy control means as claimed in claim 4, wherein said second section in the cylinder is provided with an elastic member at the inner wall thereof to energize the piston constantly toward the first section of the cylinder.

6. The underwater cleaning apparatus as claimed in claim 5, wherein said floats are operatively provided on both sides of the impellers so as to be arranged in point-symmetry.

7. The underwater cleaning apparatus with posture control means as claimed in claim 1, wherein said movable substances are metal balls.

8. The underwater cleaning apparatus with posture control means as claimed in claim 1 wherein said movable substance is mercury.

9. The underwater cleaning apparatus with posture control means as claimed in claim 1 wherein said hollow wall is rectangular in section.

10. The underwater cleaning apparatus as claimed in claim 1 wherein said wheels are driven by individual oil pressure.

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